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Operational Qualifications in the Information Architecture Context

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Abstract

In order to fight the effects of the current international crisis, and in order to keep up with the internal budget cuts and reductions, the Portuguese Air Force is forced to develop mechanisms to improve its efficiency as an organization. An example of these mechanisms is the Integrated Management System (SIAGFA). Its main goal is to increase organizational efficiency, by the reduction of human and material resources, to perform certain management tasks in different areas of interest. The focus of this research is centered mainly in the SIAGFA operational component, specifically in information regarding the operational qualifications, concerning each crew member. It determines whether the individual has the necessary skills to fly a specific aircraft and what missions he can execute within the range of missions for which the aircraft is intended. The research, based on Organizational Engineering concepts and on Information Architecture methodology, identified the necessary requirements for integrating the different operational qualification events within the same baseline, providing a basis framework for cataloguing and identifying who is qualified, who is missing some event to be qualified and who has lost qualification.

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1. Introduction

The "Sistema Integrado de Apoio à Gestão da Força Aérea" (SIAGFA) is an information system whose main goal is to provide data and arrange it in the form of information so that its users can query a single system, increasing the efficiency of the information flowing throughout the organization. This system is divided in several modules, each relating to different areas of interest. However, the focus of this paper is essentially fixed in one of these modules, the "Sistema Integrado de Gestão Operacional" (SIGOP), and its interactions with the other modules, including the "Sistema Integrado de Gestão de Apoio ao Pessoal" (SIGAP) and "Módulo de Gestão de Manutenção" (MGM). Through the analysis on how these modules work together it was realized that not only the information system provides a low amount of information regarding the crews' qualifications, but also the little information that is available is scattered and outdated.

This document is divided into the following sections: "Concepts and Application", in section 2, provides the relevant literature review; section 3, "Integration of Operational Qualifications in the SIAGFA", presents the research model's construction and validation; section 4 concludes and presents future work.

2. Concepts and Application

This section aims to summarize the theoretical foundations which permitted reaching the model presented in the third section.

2.1. Organizational Engineering and Organizational Self-Awareness

Organizational Engineering (OE) is a set of principles and practices that answer the question "*How to draw and improve on a holistic approach, all elements associated with a business, through the use of analytical methods and tools to better achieve its strategic objectives?*" [1]. OE is also considered as "*the body of knowledge, principles and practices related to analysis, design, implementation and operation of a business*" [1] and as such, this scientific area wants to study and develop methods and tools to align the business processes with the organizations' strategic goals creating a new concept of Knowledge, which is a necessary tool to manage these changes and improve management capabilities in real time. Vicente [2], stated that "this discipline's goal is to reduce the existing gap between the soft sciences and the hard sciences. Soft sciences are related with social and management concerns, while hard sciences are related to the technical aspects of the organization. With this we can say that in the same way people know who they are and what they are doing, should also be aware of where they are in the organization, what they are doing and how they are doing it".

Through the strategy, it is aimed to accomplish the established goals, helping it, together with other tactics, to achieve the wished result, amplifying the last one, its own vision, through the definition of the goals and specific objectives already spoken [3].

According to Zacarias [4], organizational Self-awareness (OSA) is defined as a process that firstly involves the efforts of an individual member of the organization to be aware of its work environment through its perception. This perception is influenced by a large number of factors, some related to the psychological traits of the individual, others related to their own work environment. In another perspective, OSA is seen from the point of view of the organization. It is considered that an organization is "Self-Aware" when it knows who belongs to it, what its co-workers do and how their task contributes to its evolution, while at the same time, each individual is aware of his contribution to the organization, his position, the way things work within it and how all the individuals work as a whole.

2.2. Information Architecture

Information Architecture is the structure of informational entities necessary for the pursuit of the organization's business processes. In other words, information architecture defines which informational entities are required and how do they relate. Thus, informational entity is equivalent to the business concept, meaning the information required for the business.

It's now important to define that an informational entity can mean anything (person, place, or something physical, etc.) That is meaningful in the business context and is relevant to the organization. It is characterized by having a name (simple noun), a unique identifier, whereby their occurrences are uniquely recognized in the organization, a simple description and the processes and relationships with other entities and information systems.

Regarding the information's management, its main principles are the acquisition, classification, storage, editing, quality control, preservation, distribution and the information analysis.

The nature of the information must be appropriate to the various types of management: Strategic, Operational and Directional (tactical). The strategic management level covers enterprise decisions in the medium and long term, requiring global information quarterly, biannually and annually, and these are primarily aimed at managing innovation, resource definition and finally solving important problems. The directional management covers coordination and planning decisions of a subject in the short and medium term, requires aggregate information on the subject to the month and quarter, focusing equally on problem solving, innovation and resource management. At the operational level operational decisions are made concerning an activity with immediate effect, requiring detailed information about the day and week. Its main area of action is the problem solving, using the resources and dedicate as a last priority to innovation.

Concerning the information taxonomy, data can be classified as historical or projected, or primitive and derived public or private. The different data types determine the characteristics of the access and the information systems that manage them.

The primitive data depend on a single fact or occurrence in the organization, for example, the record of the date, amount and stakeholders of each transaction. The derivatives depend on various facts and events in the organization. Data is calculated, aggregated and summarized. Historical data records facts that happened using accurate and correct values. There is an agreement on when or how to calculate it. The projected data is an estimate or forecast of events that will happen. The concept of right or wrong does not apply to projections. Normally there is no unanimity on how to obtain or calculate it. Finally the public data is the one which integrity is maintained by the organization, it may be the only record of a fact in the organization, and is relevant to several individuals in the organization. Lastly, private data reflects the immediate needs of each individual, is owned and interests to a single individual.

Information architecture follows the relationship between users, content and context. The context refers to the organization's objectives, policies, culture, technology and human resources. The contents mentions documents, formats / types, objects, metadata and the existing structure. And users contemplate audience, tasks, needs, information seeking behavior, experience and vocabulary.

According to Gama et al [5], the information architecture defines a view of the information that actors need to develop their activities.

2.3. Agility, Flexibility and Adaptability

Adaptability, flexibility and agility are three concepts which are interconnected, in a way that they always arise together, with the combination of the first two giving out the third. Agility is the ability to continuously monitor market needs, quickly respond with new products, services or information, and quickly introduce new technologies and rapidly changing business processes. Agility can create tangible benefits for many aspects of organizational performance. According to Mangas [6] flexibility is the ability to achieve success in different ways, allowing organizations to quickly recognize changes in the environment, reduce risk by providing multiple futures and save time on contingency plans. Adaptability is the ability to change the strength of the organization and work processes when necessary according to changes in its surrounding environment.

2.4. Modeling

A model is any simplistic interpretation of reality, helping to understand the system to be developed.

Modeling presents a set of fundamentals that are necessary to note, so you can understand the context in which it is run.

It begins by defining the universe of discourse (UOD), or system, which is the fragment of the real world about which tasks modeling and construction of the system are focused. Such identification requires knowledge of the system boundary and its real-world entities. It is necessary to take into account that there may be different types of systems.

The modeling concept has a structure consisting of a set of basic abstractions that allow the identification and characterization of the entities represented. Examples of these concepts are: Entities, Informational Entity; Classes; Aggregates; Events and Relations.

Regarding the modeling language, this has to do with the structuring and specification of the concepts, in one or more languages that can be formal or informal, textual or graphic creating an unambiguous association between the structure of concepts and the respective modeling language. The level of graphic modeling languages, it is important to refer the notation, which consists in the visual presentation of various components of the concepts underlying structure.

The model is the result of a system interpretation and conception, which varies on different points of views and their specifications involves a certain level of abstraction and detail. In turn, a scheme is the specification of a model, using a particular language that can be formal or informal, textual or graphical, and in cases of graphical representation, it is given the name of the diagram. Models present themselves as a simplified interpretation of reality, allowing a better understanding of the system to be developed, especially in cases of complex systems, and must have the ability to meet various needs, in accordance with the interests of different stakeholders. To illustrate different representations of the model are used views, one view is the representation of a system from a perspective related to a set of interests, since the viewpoints consist of a conventions for specifying the construction and use of views.

Modeling is a well-accepted and proven engineering technique today, which presents several benefits, including the fact that enable knowledge sharing between users and technicians and between different types of technicians, also enables better management of projects, providing cost and time, allows the visualization of a system over time, can specify the structure and behavior of a whole system, and documenting the decision making undertaken.

Modeling is based upon a set of four principles. The first argues that the choice of models to create has a profound influence on the way the problem is attacked and consequently, as the solution is treated, the second suggests that each model can be expressed at different levels of precision / abstraction, the third principle states that the best designs reflect reality, and the final argues that no single model is sufficient.

2.5. Balanced Scorecard

The most important capability in any organization is the ability to transform strategies into action. This becomes more difficult as larger or more complex the organization is, because the distance between those who formulate the strategy and those who carry it is significant. With the increasing complexity of the organizations, the need to communicate strategic intent and provide the management framework that aligns the business capabilities with the requirements of the competitive market arises [7]. Kaplan and Norton [8] said that "*strategy has never been so important. As the economy moves rapidly from the Industrial Age to the Information Age, which is characterized as a global knowledge-based competition, each organization must rethink fundamental assumptions in racing. With the growing connection of the global economy, every business should build their own feedback systems to effectively monitor their activities to achieve their strategic goals*".

In 1992, two Harvard Business School professors, Robert Kaplan and David Norton, created the Balanced Scorecard. This model was initially presented as a form of evaluation and business performance, resulting in a strategic management methodology – "*BSC focuses on how to successfully execute business strategies using this management model. Presents a new management system for organizations to focus on long-term customers, employees, develop new products and new systems, rather than focusing only on short-term profit*". Thus, BSC is the development of a logical design of a generic system management for organizations, where it is defined and implemented a set of interpretations, control variables and goals, so that organizations may improve their performance and growth over time. These must be placed by the administrator via, for example, management of information systems.

It can be argued that the BSC presents in a logical, objective and intelligent way, a sort of pre-existing ideas and concepts. Its application adequately turns into a lot of benefits, such as the integration of financial and non-financial, communication and feedback strategy, link strategy with planning and budgeting, among others. However, it cannot be regarded as the only resolution to all the problems of strategic planning and strategic management.

3. Integration of Operational Qualifications in the SIAGFA

This section is intended to explain the logic of building a model for the integration of the operational qualifications in SIAGFA, the critical factors to implement and the validation of this model through an example.

3.1. Model

Through the analysis of the Portuguese Air Force's current situation concerning to their pilots' operational qualifications and with the use of the concepts presented above in this document, it was realized that the organization needs a model that integrates operational qualifications in SIAGFA.

However, for this to be possible, it is necessary to firstly understand the whole process that involves the operational qualifications, by getting to know all of the intervening informational entities and how the information flows through the organization.

In order to better understand this whole process, each informational entity present in the operational qualifications domain was defined, created and inserted in a diagram that represents information flow that starts with a mission request and ends in the necessary events that a particular crew has to fulfill in order to obtain the necessary qualifications to perform the mission.

Information architecture determines which informational entities are necessary to pursue the organization's business processes and how do they relate to each other. It was also retained that an informational entity is characterized by having a name, a unique identifier, a simple description and their relationships with processes, other entities and information systems. All of this has the purpose of easing the communication inside the organization.

With the help of the Portuguese Air Force's internal regulation, it was possible to set all of the informational entities involving the operational qualifications. And with the creation of a new informational entity named "requirement", that aggregates the whole data about a qualifying event and associates it to a certain crew member's qualification level, it is now possible to create a sequence where informational entities like "mission", "squadron", "crew", "airplane", "on-board function" and "qualification level" are able to be all together in the same place and also related with each other.

With this, it is possible to create the following relation between the informational entities: after looking at the mission data, it is possible to identify which is the most suitable squadron to successfully accomplish the mission. In its turn, the squadron assigns a crew and an aircraft, which together presupposes the existence of certain on-board functions. According to the air force regulation 500-2 [9], each on-board function requires a certain level of qualification, which in turn is directly related to the mission previously assigned. In order to maintain or achieve a certain qualification level, the crew member has to attain with various requirements, and this informational entity is the variable that determines the crew member's qualification level.

The requirements come here as an innovative informational entity, since this concept does not yet exist within the operational activity of the Portuguese Air Force.

The requirements are therefore an informational entity which divides into the informational entities "Matrix of Requirements" (or simply "requirement") and "Event Log" (or "event") which interact with each other by using the log of the qualifying events to fill an array of requirements necessary to obtain or maintain a certain qualification level.

From these informational entities, the focus of this work centers essentially in the qualification level and in the requirements. This is because these fields represent a big gap, in terms of information system. Currently, the SIAGFA's user can't get an array of the requirements related to each mission type, as described in the Air Force's policy, which relate him to a certain qualification level.

In this context, a model was designed that allows the creation of a completely new module on the operational qualifications in which are set each squadron's matrix of requirements and in which it is possible to have a log containing all the qualifying events possible grouped by aircraft and / or mission type, so that, when crossing the data with the matrix of requirements it is possible to observe which qualifying events the crew member has done and to what qualification level they correspond. All of this requires a good communication between the system's modules so that the user does not have to enter the same data multiple times, but at the same time the information remains available wherever the user needs it.

But after all this work, there is still a main question that needs to be answered: in what way the organization benefits from this model and how does it interact with the Portuguese Air Force and its information systems? To answer this question, it was created the "Model for the insertion of Operational Qualifications on the Integrated Information System" which is presented in Fig. 1, representing a summary of what has been said and providing a pictorial conception of how this interaction works. This model was originally made using the Portuguese language and it is now translated to English.

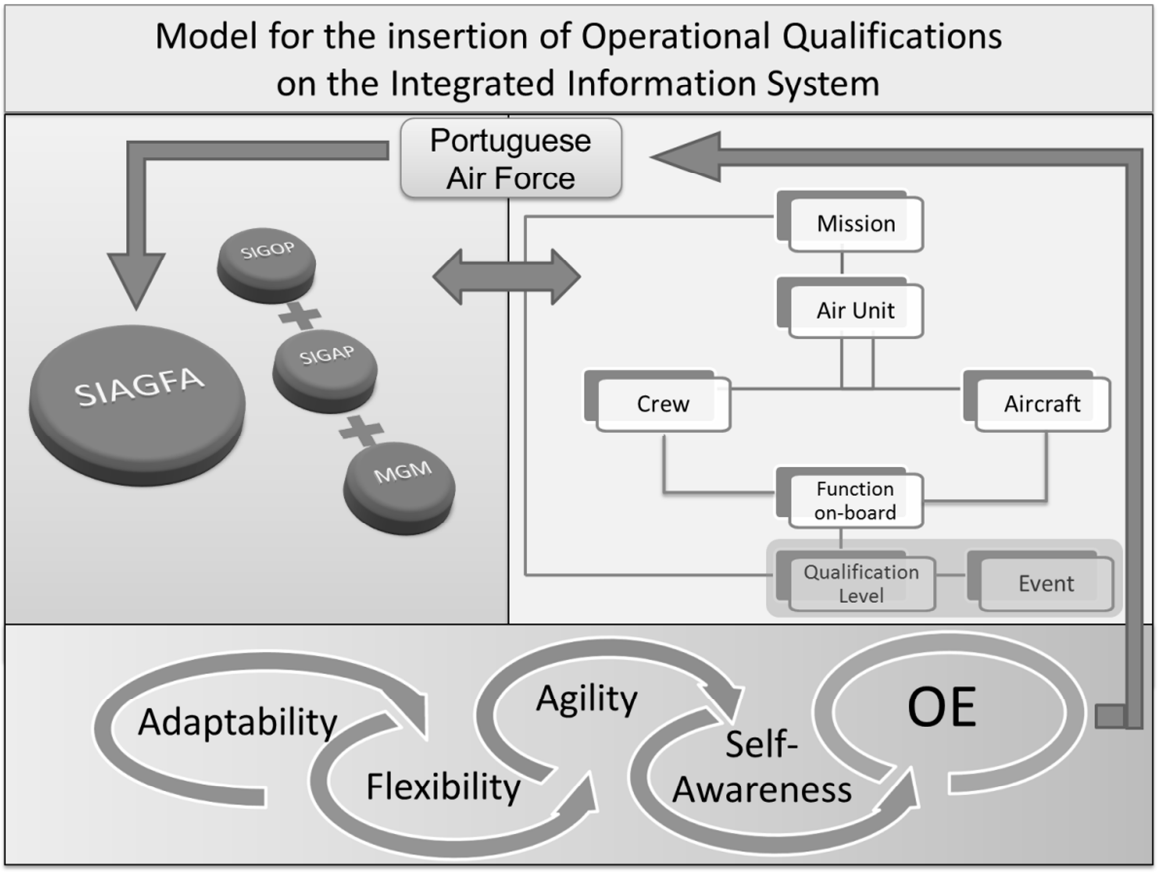

Fig. 1. Model for the insertion of Operational Qualifications on the Integrated Information System [10].

The diagram in Fig. 1 describes the process surrounding the Operational Qualifications, however this is only a context, since what it really intends, is to integrate in SIAGFA the highlighted boxes.

Through the creation of this model it is now possible to observe the direct relationship of "On-board Function" with the "Qualification Level" as well as the relationship of the last with the "Mission" through the "Aircraft". It is also possible to observe the relationship of the "Qualification Level" with the "Requirements". In terms of benefits, this model is transversal to all of the squadrons in the Portuguese Air Force, allowing the standardization of procedures and easing its coding into information systems. This model allows the information system to be proactive in the way that it is able to have the capability to know if a certain qualifying event is about to expire and with that, alert the crew to that event. This is converted into a more agile information system and the increase of the air force's organizational self-awareness, both from the individual and the organizational perspective.

However, there are potential problems related to this process. In particular, and regarding the crew, it is still not possible to insert the assigned crew during the mission planning. This information continues to be available only after the end of a flight, referring again to the reactivity rather than proactivity of the information system. Adding to this, the implementation of the model does not imply that all qualifying events are listed in the informational system, generating a conflict between the matrix of requirements (which describes all the qualifying events) and the event log (which may not contain all the qualifying events to be made outside the flight context).

3.2. Implementation

In this topic are made some remarks regarding the implementation of the model above presented. Upon the implementation on the Portuguese Air Force, it was necessary that it was communicated and disseminated throughout the organization so that all of its members knew about an improvement that has been made into an organizational management tool that undoubtedly benefits the organization. One way to do this is through the publication of new and refreshed regulations, establishing new rules, adapted to today's needs, due to the introduction of data relating to each crew member's qualifications in the information system. Thus, the system's users have to be aware that it's their responsibility to constantly update the system, so that it can become fluid and reliable.

In order for this to happen, it is necessary to warn all those involved in the operational qualifications process that this whole procedure was target of a deep change and its success now depends on the data "feeding" made by each user, in particular in the event log. In order to standardize the use of this new tool, it is justifiable that are carried out training activities for users who need them.

The goal of this implementation is to make individuals and the organization more self-aware, since the data that concerns the qualifications will be accessible to all of the entities that are a part of this process and it can be grouped in order to provide the information as the user needs it. This will essentially make improvements in the management and planning of the operational activity, contributing to a better air force, more self-aware, more agile and more efficient.

3.3. Validation

Validation intends to assess if the designed model worked as expected in the organization. In order to achieve validation, it was necessary to perform a test to assess if the outcome of the research was aligned with the operation (business) of the organization. In this case, the test consisted in the definition of a matrix of requirements to survey all the qualifying events possible for an aircraft and submit it for approval by the respective squadron, so that it checks that all the existing events in the matrix are in agreement with the crew qualifications' manual for that aircraft. If not, it's necessary to identify the missing ones. After the affirmative decision given by the squadron, it is considered that the suggested model works and is validated.

As such, and in order to put the thesis model into practice, an Air Force's operating aircraft (Epsilon TB-30) was selected to act as a validating example. Through the assembling of a table with the description of all the qualifying events for the Epsilon aircraft, and applying a filter that only shows the "Ready for Flight" qualification level, it was possible to display all the events needed to maintain this qualification, the relation to the mission and how often they have to be performed.

Through this example, it was possible to demonstrate that the model works correctly and according to the user requests, thereby validating its instantiation.

Performing now a concept test it is possible to check the validation or invalidation of assumptions questioned at the beginning of this work. Giving now the example of the matrix of requirements, the author uses the description of the requirements that verify the qualification to land the Epsilon aircraft during daytime: it is considered that the pilot is qualified on daytime landing if he performs three repetitions within thirty days. This event is made by who performs the on-board function "pilot", fulfilling the mission "Aircraft Basic Qualification" and intended to maintain the qualification level "Ready for Flight" and the tactical qualification "Wing". Through the consultation of a given crew member's event log, the system is able to check whether if he is or is not qualified for daytime landing.

With this, it is now possible to check if the hypothesises created for this model are validated. These hypotheses were:

1- Through the integration of the Operational Qualifications in SIAGFA it will be possible to know the number of ready crews in near real-time.
2- With this tool it is possible to know the minimum crew number needed to fulfil the mission, which ones are attributed to the squadron and which ones are qualified.
3- The Portuguese Air Force’s information systems have the ability to provide all information concerning the operational qualifications, although they need a slight adjustment.

With the facts given above it is not possible to conclude whether if a crew is ready or not, given that the information provided is only related to their qualifications and not their daily situation. As such, it is considered that the first hypothesis is not validated. However, it is possible to know what is the minimum crew required to fulfil the mission, which are conferred to the squadron and what are qualified, thus validating the hypothesis 2.

Creating a matrix of requirements allows the clear display of all the data relating to qualifying events as such their importation into the information system becomes relatively reasonable given its ability to contain and interpret data. With this, the hypothesis 3 it is also considered validated.

4. Conclusion

In conclusion, the main goal of this work was to locate and then fill some gaps constant in the Portuguese Air Force’s operational qualifications. Thus, this work evolved in a way that the SIGOP inserted in SIAGFA would be improved through the creation and insertion of the informational entities “requirement” and “event” in the operational qualifications process. These aimed to establish a coherent chain of relationships between all the informational entities engaging in the process, so that the final product of the qualifying process was to expose all the qualifying actions undertaken to achieve or maintain a certain level of qualification. For this to happen, and using the principles learned with enterprise information systems architecture, specifically with the information architecture, it was necessary to define each informational entity in the author’s model, which creation was based on modelling.

As a final result, by applying the model to the Portuguese Air Force it is obtained a scorecard composed of the various attributes of the informational entity “requirement” related to each other, so that together culminate in describing an event qualifier. In addition, each qualifying event is a key performance indicator that enables users to better manage their qualification level.

The model is transversal to the squadrons, creating procedures standardization and, therefore, eases the necessity of hard coding each situation into the information system. These facts contribute to increase organizational self-awareness and its agility capability.

However, there are still remaining problems that the model cannot solve. It is still not possible to insert in the information system data related to crews before the mission’s execution, and not all the qualifying events that run parallel to the operational activity are registered in it.

In short, through this dissertation it was possible to create solutions to some of the problems encountered in the Portuguese Air Force’s operation. By creating a model for the integration of operational qualifications in the organization’s information system, it was possible to establish the connection between the qualification level of each crew member with the necessary requirements, by crossing the event log with a matrix of requirements. This allowed all informational entities engaging in operational qualifications to group each other and correlating a model representative of the whole process.

This model’s generalist approach allows the air force to standardize procedures, thereby facilitating the codification into information systems, making them more proactive.

This model will allow the organization to be more aware of each other's work and to what extent it contributes to the achievement of its goals. Moreover, as each individual will be more aware of his role in the organization and how he can contribute to its progress. As such, the organization benefits from an increase of the organizational self-awareness on both strands.

As a result of the organization's increased knowledge in its crew's qualifications, this model increases the organization's ability to change its strength when faced with changes in the surrounding environment and cannot be limited to obtain success through a unique way, providing then the adaptability and flexibility required to predict changes in surroundings and move its processes forces, in order to succeed with this, creating a more agile organization.

Therefore, this model improves the organization's business processes related to the operational qualifications by increasing its efficiency, turning the Portuguese Air Force into a more agile organization in a way that it is able to face the obstacles and difficulties created everyday by its surrounding environment.

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